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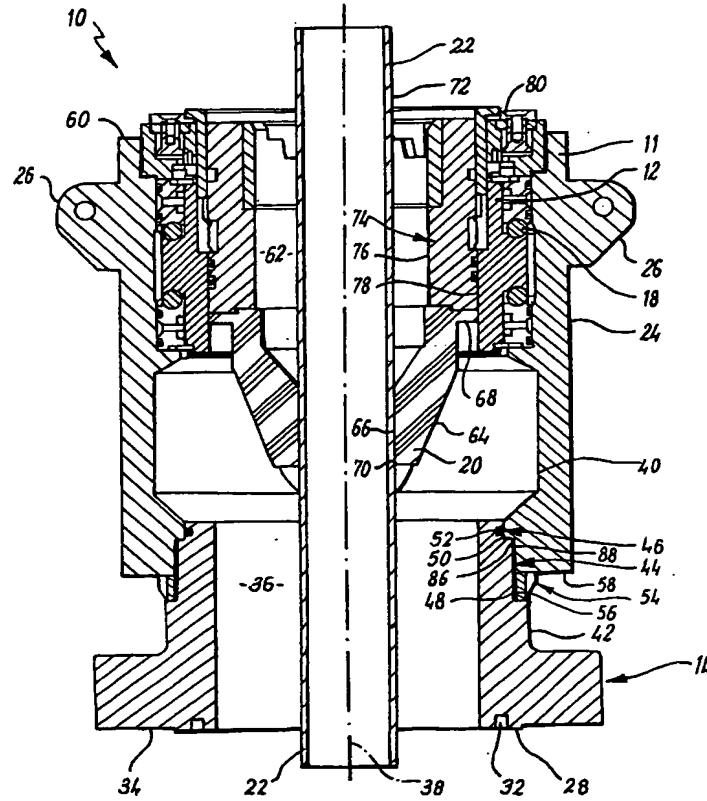
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[Continued on next page]

(54) Title: ROTATING DIVERTER HEAD



(57) Abstract: A rotating diverter head (10) for use on a blow out preventer stack of an oil, gas or geothermal well. While providing for sealing and rotation of a drill pipe (22) through the head, the head additional includes a flange on which the head is rotatable. The flange connects the head to the stack whereupon it can be rotated to align a return flow line before being locked in position.

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1    **Rotating diverter head**

2

3    The present invention relates equipment used in the  
4    drilling of oil, gas and geothermal wells and in  
5    particular, though not exclusively, to a rotating  
6    diverter head which includes an inlet flange on which the  
7    head can rotate to adjust the location of a side outlet.

8

9    In drilling a well, a drilling tool or "drill bit" is  
10   rotated under an axial load within a bore hole. The  
11   drill bit is attached to the bottom of a string of  
12   threadably connected tubulars or "drill pipe" located in  
13   the bore hole. The drill pipe is rotated at the surface  
14   of the well by an applied torque which is transferred by  
15   the drill pipe to the drill bit. As the bore hole is  
16   drilled, the hole bored by the drill bit is substantially  
17   greater than the diameter of the drill pipe. To assist  
18   in lubricating the drill bit, drilling fluid or gas is  
19   pumped down the drill pipe. The fluid jets out of the  
20   drill bit, flowing back up to the surface through the  
21   annulus between the wall of the bore hole and the drill  
22   pipe.

1 The density of the drilling fluid is adjusted such that  
2 the pressure head produced by the weight of the column of  
3 drilling fluid is slightly more or less than the pressure  
4 of the oil or gas encountered in the geological  
5 formations being drilled through. If the pressure head  
6 of the column of drilling fluid is greater than the  
7 pressure of the oil or gas, the top of the well can be  
8 open to atmosphere. It is often advantageous to allow  
9 the pressure head of the drilling fluid to be slightly  
10 less than the pressure of the oil or gas encountered in  
11 the formation. In this case, known as "underbalanced  
12 drilling", the annulus around the drill pipe needs to be  
13 sealed and the drilling fluid returning under pressure up  
14 the annulus must be diverted to a recirculating unit for  
15 pumping back down the well.

16

17 Rotating diverter heads provide a means of sealing off  
18 the annulus around the drill pipe as the drill pipe  
19 rotates and translates axially down the well while  
20 including a side outlet through which the return drilling  
21 fluid is diverted. Such rotating diverter heads may also  
22 be referred to as rotating blow out preventers or  
23 drilling heads. These units generally comprise a  
24 stationary housing or bowl including a side outlet for  
25 connection to a fluid return line and an inlet flange for  
26 locating the unit on a blow out preventer or other  
27 drilling stack at the surface of the well bore. Within  
28 the bowl, opposite the inlet flange, is arranged a  
29 rotatable assembly such as anti-friction bearings which  
30 allow the drill pipe, located through the head, to rotate  
31 and slide. The assembly includes a seal onto the drill  
32 pipe which is typically a strip of rubber.

33

1 Prior art rotatable diverter heads such as those  
2 disclosed in US Patent Nos. 4949796, 5662181, 5848643,  
3 5647444, 4480703 and 4312404 have concentrated on  
4 improvements to the sealing means, in particular the ease  
5 to which the rubber strips can be replaced. In all these  
6 diverter heads the side outlet is included in the housing  
7 of the stationary bowl and the rotatable assemblies are  
8 mounted above the side outlet to aid disassembly for  
9 maintenance.

10  
11 A disadvantage of these prior art diverter heads is that  
12 as the bowl is bolted or clamped to the blow out  
13 preventer, the side outlet is fixed at a single position.  
14 The pipework forming the return fluid line must attach to  
15 the side outlet and as both are generally fixed in  
16 position and orientation it is difficult to mate their  
17 respective flanges together.

18  
19 It is therefore an object of the present invention to  
20 provide a rotating diverter head which can be rotated to  
21 re-position the side outlet with respect to the inlet  
22 flange.

23  
24 It is a further object of the present invention to  
25 provide an improved method of connecting a rotating  
26 diverter head to a return fluid line at a blow out  
27 preventer.

28  
29 According to a first aspect of the present invention  
30 there is provided a rotating diverter head comprising:

1 a bowl member having a first bore aligned on a central  
2 axis therethrough and a second bore located  
3 substantially transverse of the central axis;

4  
5 a housing located substantially within the bowl member  
6 including first rotational means to rotate the housing  
7 relative to the bowl member and first sealing means to  
8 sealably engage the housing upon a drill pipe when the  
9 drill pipe is inserted through the first bore; and

10  
11 an inlet flange for connecting the bowl member to a  
12 blow out preventer stack, the flange including second  
13 rotational means to selectively rotate the bowl member  
14 about the central axis.

15  
16 By allowing the bowl member to rotate relative to the  
17 inlet flange and hence the blow out preventer stack, the  
18 second bore can be rotated on the central axis to aid  
19 alignment with a return flow line.

20  
21 Preferably the second rotational means comprises  
22 interconnected screw threads between the flange and the  
23 bowl member.

24  
25 Preferably also the flange further includes second  
26 sealing means to prevent the egress of fluid from the  
27 first bore through the second rotational means. The  
28 second sealing means may be an o-ring or other rubber  
29 based seal.

30  
31 Preferably the flange further includes locking means for  
32 preventing rotational movement of the bowl member with  
33 respect to the flange when the second bore is aligned.

1 Advantageously the locking means comprises a locking ring  
2 arranged around the bowl member and engageable on the  
3 screw threads.

4

5 Preferably the housing including first sealing means and  
6 first rotational means is as known in the art. Examples  
7 of such housings are disclosed in US Patent Nos. 4949796,  
8 5662181, 5848643, 5647444, 4480703 and 4312404, the  
9 contents of which are incorporated herein by reference.

10

11 Advantageously also the diverter head includes a locking  
12 cap located over the housing to hold it in place. More  
13 preferably an actuator is mounted in relation to the  
14 cap, to release the cap remotely. This arrangement  
15 removes the need for an operator to climb the BOP stack  
16 to release a clamp to again access to the bowl.

17

18 According to a second aspect of the present invention  
19 there is provided a bowl for use in a rotatable diverter  
20 head, the bowl comprising a substantially cylindrical  
21 body having a bore therethrough adapted for receiving a  
22 housing, rotatable therein and sealable to a drill pipe  
23 passed therethrough, and an inlet flange, the body and  
24 flange being rotatably coupled such that the body rotates  
25 on a longitudinal axis of the bore when the flange is  
26 attached to a blow out preventer stack.

27

28 Preferably the body and flange are rotatably coupled by  
29 interconnected screw threads on an outer surface of the  
30 body and an inner surface of the flange.

31

32 Preferably also the flange further includes sealing means  
33 to prevent the egress of fluid from the bore through the

1 rotational coupling. The sealing means may be an o-ring  
2 or other rubber based seal.

3

4 Preferably the flange further includes locking means for  
5 preventing rotational movement of the body with respect  
6 to the flange when the desired. Advantageously the  
7 locking means comprises a locking ring arranged around  
8 the body and engageable on the screw threads.

9

10 According to a third aspect of the present invention  
11 there is provided a method of connecting a rotating  
12 diverter head to a return fluid line at a blow out  
13 preventer stack, the method comprising the steps:

14

15 (a) connecting an inlet flange of the diverter head to  
16 an outlet of the blow out preventer stack;

17

18 (b) rotating the diverter head with respect to the blow  
19 out preventer stack to align a side outlet of the  
20 head with a return fluid line; and

21

22 (c) connecting the side outlet to the return fluid line.

23

24 Advantageously the method includes the step of locking  
25 the diverter head in position to prevent rotation of the  
26 diverter head relative to the blow out preventer after  
27 the side outlet is aligned.

28

29 Advantageously the method may further include the step of  
30 remotely actuating a release mechanism to release a cap  
31 of the diverter head to gain access to the spindle.

32

1 An example embodiment of the present invention will now  
2 be described, by way of example only, with reference to  
3 the accompanying drawings of which:

4

5 Figure 1 is an isometric view of a rotating diverter head  
6 according to an embodiment of the present invention;

7

8 Figure 2 is a cross sectional view taken vertically  
9 through the head of Figure 1;

10

11 Figure 3 is a side view of the head of Figure 1 mounted  
12 on the top of a blow out preventer stack;

13

14 Figures 4 and 5 are top views of the head of Figure 1  
15 illustrating first and second alignment positions of the  
16 side outlet; and

17

18 Figure 6 is an exploded schematic view of a rotating  
19 diverter head according to a further embodiment of the  
20 present invention.

21

22 Reference is initially made to Figures 1 and 2  
23 illustrating a rotating diverter head, generally  
24 indicated by reference numeral 10, in accordance with an  
25 embodiment of the present invention.

26

27 Head 10 includes a bowl 11 which is generally a  
28 cylindrical body, a rotating spindle 12, an inlet flange  
29 14 and a side outlet 16. Spindle 12 forms a housing which  
30 rotates in anti-friction bearings 18. Spindle 12 also  
31 includes a seal 20 which sealably engages a drill pipe 22  
32 located through the head 10.

33

1 In the prior art diverter heads these features are found  
2 with the bowl and flange typically being of single piece  
3 construction and thus referred to as a stationary  
4 housing. As can be seen in Figure 2, the bowl 11 and  
5 flange 14 are separate pieces in the present invention.  
6 It is the arrangement of the flange 14 and bowl 11 which  
7 relate to the present invention and thus the spindle 12  
8 together with its bearing 18 and sealing means 20 may be  
9 of any type as is known in the art. For clarity one  
10 embodiment of a spindle 12 will be described herein,  
11 however recognition that any arrangement of spindle 12  
12 could be used with/in the present invention, will be  
13 appreciated.

14

15 In the embodiment shown, head 10 comprises a cylindrical  
16 body or bowl 11, located upon a flange 14. Bowl 11 has an  
17 outer surface 24 upon which are located lugs 26 for  
18 lifting and positioning the head 10 on a blow out  
19 preventer stack (not shown). Flange 14 has a base 28  
20 compatible with the top flange of the blow out preventer  
21 stack and the two are linked via screws located in ports  
22 30. The dimensions of the base 28 of the flange 14 are  
23 determined by an international standard to ensure proper  
24 mating with other flanges of the same size and pressure  
25 rating. Once positioned the flange 14 is fixed in  
26 relation to the blow out preventer stack. A seal groove  
27 32 on the bottom face 34 of the base 28 provides for an  
28 o-ring to be inserted to prevent the egress of fluid from  
29 the head 10 between the base 28 and the blow out  
30 preventer stack.

31

32 The bowl 11 and flange 14 provide a bore 36 on a central  
33 axis 38 through the head 10. The side outlet 16 is

1 arranged to direct fluid in a perpendicular direction  
2 from the central bore 36. The bowl 11 and the flange 14  
3 mate between a respective inner surface 40 of the bowl 11  
4 and an outer surface 42 of the flange 14. The inner  
5 surface 40 includes a threaded bore 44 and a sealing bore  
6 46. The diameter of sealing bore 46 is less than the  
7 diameter of threaded bore 44. The outer surface 42 of  
8 flange 14 includes a threaded section 48 and a sealing  
9 section 50. The threads of threaded section 48 engage  
10 the threads of threaded bore 44 of bowl 11. The sealing  
11 section 50 comprises a seal groove 52 into which is  
12 located an o-ring or rubber strip (not shown). When the  
13 threads of the threaded bore 44 engage the threads on the  
14 threaded section 48, the sealing section 50 locates  
15 against the sealing bore 46, thus providing sealing  
16 engagement between the bowl 11 and the flange 14 to  
17 prevent the egress of fluid from the head 10 at this  
18 location. The seal will be maintained as the threads are  
19 moved relative to each other so that the bowl 11 can  
20 rotate on the central axis 38 relative to the flange 14.  
21 This rotation is selective and continuous through 360  
22 degrees around the central axis.

23  
24 Located around the flange 14 is a locking ring 54. Ring  
25 54 is a threaded lock ring which comprises a threaded  
26 inner surface 56 that engages threaded section 48 of  
27 flange 14. Ring 54 can be rotated upwards towards the  
28 base 58 of bowl 11 to prevent movement of the bowl 11 and  
29 thus lock the bowl 11 to the flange 14.

30  
31 Toward an upper end 60 of bowl 11 is located a spindle 12  
32 or housing. Spindle 12 includes a through bore 62 located  
33 on the central axis 38. A drill pipe 22 may extend

1 axially through the bore 62. Spindle 12 includes a  
2 stripper 64 as is known in the art. Stripper 64 comprises  
3 a moulded, resilient seal 20 having a through-hole 66  
4 and a flange 68. The nominal diameter of through-hole 66  
5 is somewhat smaller than the diameter of drill pipe 22  
6 such that the inner surface 70 of the through-hole 66  
7 sealably engages the outer diameter 72 of the drill pipe  
8 22. Spindle 12 further comprises a carrier 74. Carrier  
9 74 has a cylindrical body providing a through-hole 76  
10 concentric to the central axis 38 and an outer surface  
11 78. Flange 68 seals against the carrier 74. At the outer  
12 surface 78 of carrier 74 is located a bearing housing 80.  
13 Carrier 74 is sealably engaged to bearing housing 80.  
14 However, in one or more embodiments the carrier 74 may be  
15 disengageable from the bearing housing 80 so that the  
16 seal 20 of the stripper 64 can be easily removed from the  
17 head 10 for maintenance or replacement. Housing 80  
18 includes anti-friction bearing 18 which allow the bearing  
19 housing 80 to rotate within the bowl 11. By their  
20 engagement, when housing 80 rotates the stripper 64 and  
21 carrier 74 will rotate in a fixed relationship. Thus the  
22 spindle 12 can rotate within the bowl 11 while  
23 maintaining a seal against the drill pipe 22 passing  
24 there through. Thus the drill pipe 22 can rotate or  
25 reciprocate unheeded through the head 10. The seal 20  
26 also ensures that fluid travelling up bore 36 is directed  
27 through the side outlet 16 for re-circulating down the  
28 drill pipe 22.

29  
30 Reference is now made to Figures 3 through 5 which  
31 illustrate the rotating diverter head 10 in use. To  
32 operate, lock ring 54 is threaded onto threaded section  
33 48 of flange 14. Flange 14 is threaded into bowl 11

1 until face 86 of flange 14 contacts face 88 of bowl 11.  
2 Lock ring 54 is threaded until it contacts the base 58 of  
3 bowl 11. The rotating diverter head 10 is mounted onto  
4 annular blowout preventer 82 of a stack (not shown) using  
5 lugs 26 to assist its movement. Head 10 is fixed to blow  
6 out preventer 82 by mating flange 14 to outlet flange  
7 connection 84 of annular blowout preventer 82 using  
8 threaded studs located through ports 30.

9

10 A return flow line 90 is attached to an outlet flange 92  
11 of the side outlet 16, as is shown in Figures 3 and 5.  
12 Flow line 90 is typically a section of fixed piping  
13 connected to a separator (not shown). Referring now to  
14 Figure 4, if flow line 90 is not aligned with outlet  
15 flange 92, i.e., if the axis 94 of flow line 90 is not  
16 co-linear with the axis 96 of outlet flange 92, the head  
17 10 must be rotated about the central axis 38 until the  
18 axis 96 of outlet flange 92 is co-linear with the axis 94  
19 of flowline 90.

20

21 Rotating diverter head 10 is rotated about its vertical  
22 axis on the central axis 38 by unthreading lock ring 54,  
23 rotating bowl 11 on the threads of the threaded bore 44  
24 against the threads of threaded section 48 of flange 14,  
25 until the axis 96 of outlet flange 92 is co-linear with  
26 the axis 94 of flowline 90. Lock ring 54 is then threaded  
27 upward and tightened against the base 58 of the bowl 11.

28

29 Reference is now made to Figure 6 of the drawings which  
30 illustrates a rotating diverter head, generally indicated  
31 by reference numeral 110, according to a further  
32 embodiment of the present invention. Like parts to those  
33 of Figures 1 to 5 have been given the same reference

1 numeral with the addition of one hundred. Head 110  
2 includes a flange 114 for location on a stack, a bowl 111  
3 into which is located a spindle 112 as in the first  
4 embodiment. Head 110 operates in the same manner as in  
5 the first embodiment with flange 114 being located on a  
6 stack; bowl 111 being rotatable on the flange by virtue  
7 of thread 148 and lockable via ring 154; rotation  
8 allowing alignment of side outlet 116 with the head 110  
9 in place; and rotation of a drill string available  
10 through rotation of spindle 112 in bowl 111. This  
11 embodiment further includes a locking cap 98. Locking  
12 cap 98 screws onto the bowl 111 while still providing for  
13 rotation of spindle 112. The locking cap 98 is in  
14 contrast to typical heads on which a clampo is usually  
15 mounted to secure spindle 112 in place. Cap 98 includes  
16 an extending plate 97.

17  
18 Bowl 111 includes a surface 95 onto which is located an  
19 actuating cylinder 99. Through a shaft 93 of the  
20 cylinder contact and consequently movement of plate 97  
21 can be made to release or tighten the cap 98 on the bowl  
22 111. Cylinder 99 can be operated remotely. This feature  
23 has the advantage of limiting the need for an operator to  
24 climb the BOP stack in order to tighten the spindle 112  
25 against the drill string.

26  
27 In prior art diverter heads the inlet flange 14, 114 is  
28 either welded or otherwise immovably and permanently  
29 attached to the bowl 11, 111. This means that the  
30 relationship between the inlet flange and the side outlet  
31 is fixed preventing movement of the side outlet to aid  
32 alignment with a return flow line. Therefore the  
33 principle advantage of the present invention is that it

1 provides a rotating diverter head where the side outlet  
2 can be re-aligned when the head is connected to a blow  
3 out preventer, or other stack.

4

5 A further advantage of the present invention is that it  
6 provides a diverter head in which the inlet flange may be  
7 interchangeable so that the size and pressure rating of  
8 the diverter head can be varied without the need to  
9 change the spindle.

10

11 Modifications may be made to the invention herein  
12 described without departing from the scope thereof. For  
13 example, the threaded bore and threaded section may be  
14 replaced by a pin and groove arrangement. The groove  
15 being a spiral into which the pin may travel  
16 circumferentially around the inner or outer surface of  
17 the flange or bowl, respectively.

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1

2 **CLAIMS**

3

4 1. A rotating diverter head comprising:

5

6 a bowl member having a first bore aligned on a  
7 central axis therethrough and a second bore located  
8 substantially transverse of the central axis;

9

10 a housing located substantially within the bowl  
11 member including first rotational means to rotate  
12 the housing relative to the bowl member and first  
13 sealing means to sealably engage the housing upon a  
14 drill pipe when the drill pipe is inserted through  
15 the first bore; and

16

17 an inlet flange for connecting the bowl member to a  
18 blow out preventer stack, the flange including  
19 second rotational means to selectively rotate the  
20 bowl member about the central axis.

21

22 2. A rotating diverter head as claimed in Claim 1  
23 wherein the second rotational means comprises  
24 interconnected screw threads between the flange and  
25 the bowl member.

26

27 3. A rotating diverter head as claimed in Claim 1 or  
28 Claim 2 wherein the flange includes second sealing  
29 means to prevent the egress of fluid from the first  
30 bore through the second rotational means.

31

32 4. A rotating diverter head as claimed in any preceding  
33 Claim wherein the flange includes locking means for

1        preventing rotational movement of the bowl member  
2        with respect to the flange when the second bore is  
3        aligned.

4

5        5. A rotating diverter head as claimed in Claim 4  
6        wherein the locking means comprises a locking ring  
7        arranged around the bowl member and engageable on  
8        the screw threads.

9

10      6. A rotating diverter head as claimed in any preceding  
11      Claim wherein the head includes a locking cap  
12      located over the housing and engageable to the bowl.

13

14      7. A rotating diverter head as claimed in Claim 6  
15      wherein an actuator is mounted on the head to  
16      remotely lock and unlock the cap.

17

18      8. A bowl for use in a rotatable diverter head, the  
19      bowl comprising a substantially cylindrical body  
20      having a bore therethrough adapted for receiving a  
21      housing, rotatable therein and sealable to a drill  
22      pipe passed therethrough, and an inlet flange, the  
23      body an flange being rotatably coupled such that the  
24      body rotates on a longitudinal axis of the bore when  
25      the flange is attached to a blow out preventer  
26      stack.

27

28      9. A bowl as claimed in Claim 8 wherein the body and  
29      the flange are rotatably couple by interconnected  
30      screw threads on an outer surface of the body and an  
31      inner surface of the flange.

32

33      10. A bowl as claimed in Claim 8 or Claim 9 wherein the

1 flange includes sealing means to prevent the egress  
2 of fluid from the bore through the rotational  
3 coupling.

4

5 11. A bowl as claimed in any one of the Claims 8 to 10  
6 wherein the flange includes locking means for  
7 preventing rotational movement of the body with  
8 respect to the flange when desired.

9

10 12. A bowl as claimed in Claim 11 wherein the locking  
11 means comprises a locking ring arranged around the  
12 body and engageable on the screw threads.

13

14 13. A method of connecting a rotating diverter head to a  
15 return fluid line at a low out preventer stack, the  
16 method comprising the steps:

17

18 (a) connecting an inlet flange of the diverter head  
19 to an outlet of the blow out preventer stack;

20

21 (b) rotating the diverter head with respect to the  
22 blow out preventer stack to align a side outlet  
23 of the head with a return fluid line; and

24

25 (c) connecting the side outlet to the return fluid  
26 line.

27

28 14. A method as claimed in Claim 13 further including  
29 the step of locking the diverter head in position to  
30 prevent rotation of the diverter head relative to  
31 the blow out preventer after the side outlet is  
32 aligned.

33

1 15. A method as claimed in Claim 13 or Claim 14 further  
2 including the step of remotely actuating a release  
3 mechanism to release a cap on the diverter head to  
4 adjust the head against a drill pipe passing  
5 therethrough.

6

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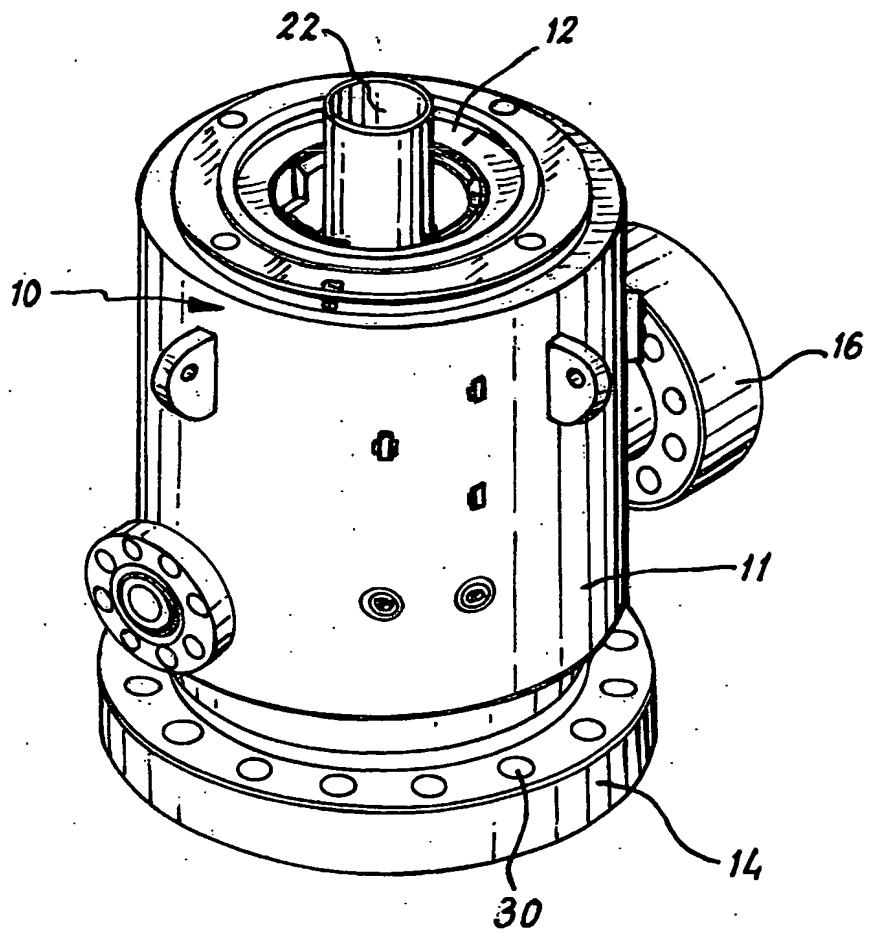
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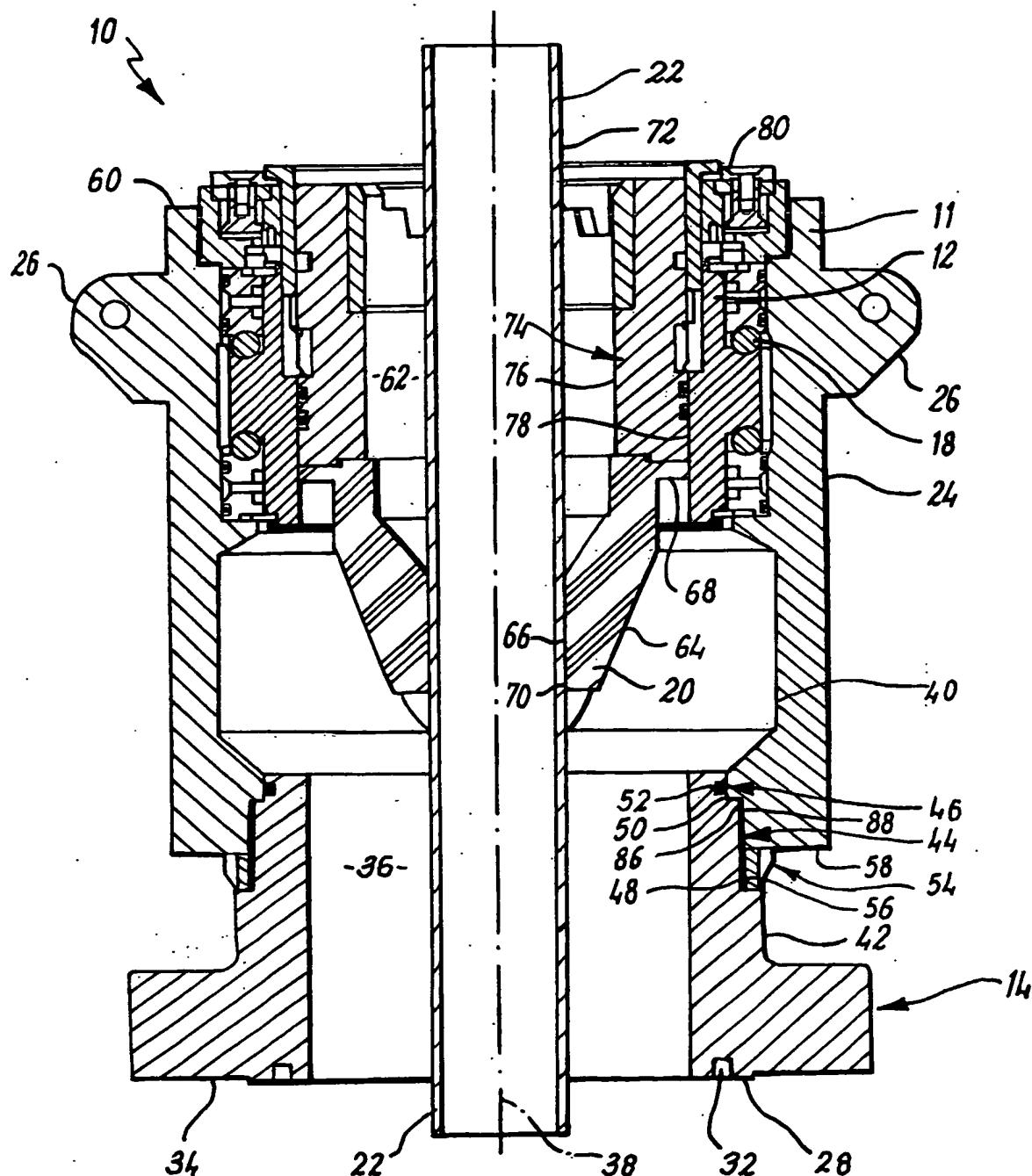
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$\frac{1}{4}$ FIG. 1

$2\frac{1}{4}$ **FIG. 2**

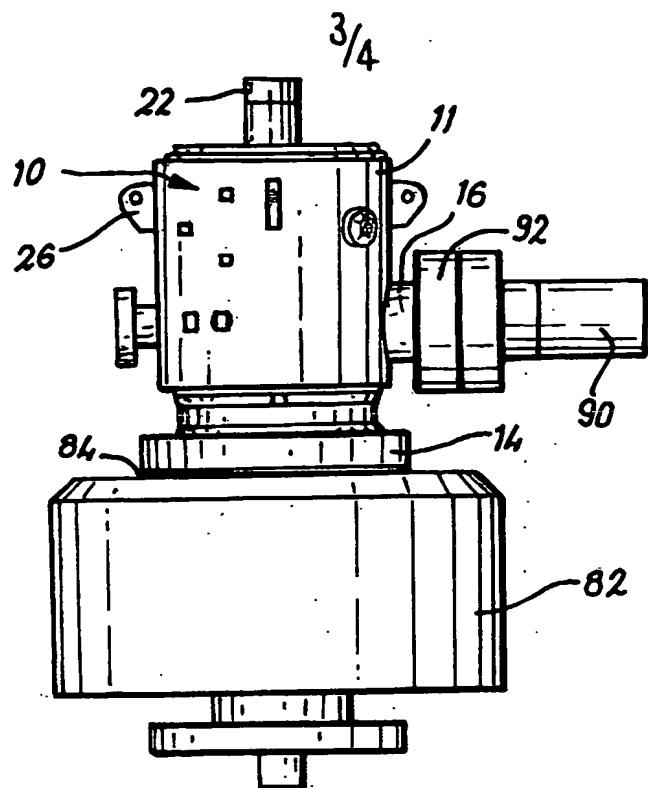


FIG. 3

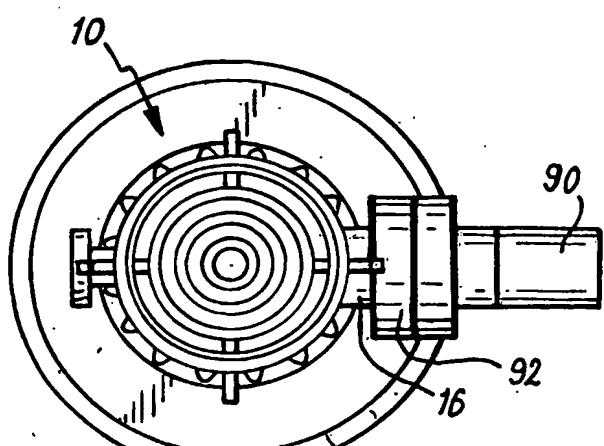


FIG. 4

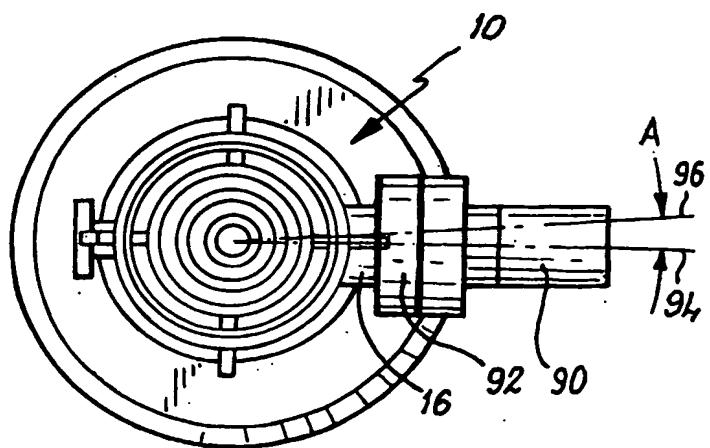
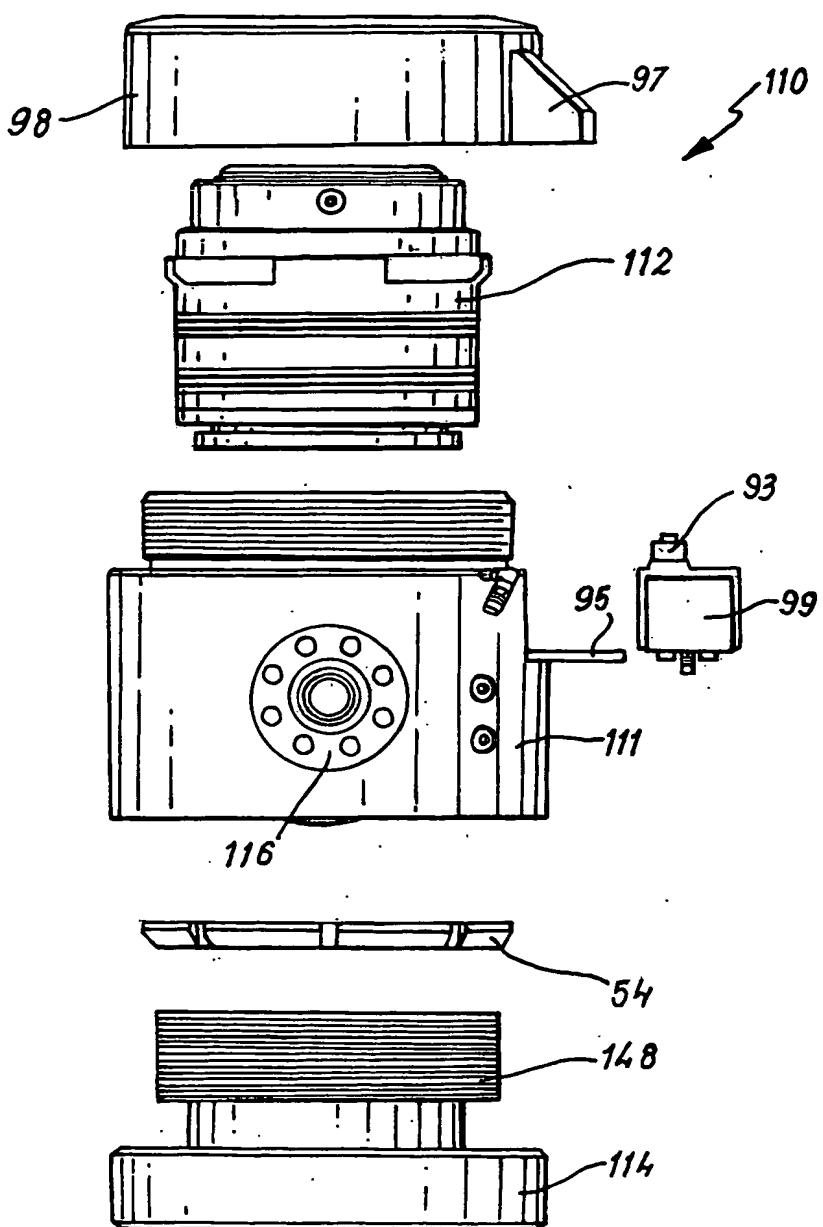


FIG. 5

4/4

**FIG. 6**

## INTERNATIONAL SEARCH REPORT

Internat Application-No.  
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IPC 7 E21B33/08

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 312 404 A (MORROW JOHN T) 26 January 1982 (1982-01-26) cited in the application figure 2 ---	1-15
A	US 5 662 181 A (WILLIAMS JOHN R ET AL) 2 September 1997 (1997-09-02) figure 3 ---	8
A	US 5 305 839 A (KALSI MANMOHAN S ET AL) 26 April 1994 (1994-04-26) column 2, line 47 - line 49; figure 2 ---	1-15

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

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Date of the actual completion of the international search

6 October 2003

Date of mailing of the international search report

15/10/2003

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Bellingacci, F

**INTERNATIONAL SEARCH REPORT**

Internal	Application No
PCT/GB 03/02394	

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 4312404	A 26-01-1982	NONE		
US 5662181	A 02-09-1997	NONE		
US 5305839	A 26-04-1994	CA GB	2111995 A1 2274492 A	20-07-1994 27-07-1994